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## (54) Monitoring system for radio communication apparatus.

(57) The monitoring system for a radio communication apparatus includes a base station and a plurality of portable units for monitoring a state of each of said portable units through said base station. Furthermore, it comprises means disposed in said base station for transmitting a first asking signal to each of said portable units for a predetermined short period; means disposed in each of said portable stations for replying a response signal in response to said first asking signal only when a state of each of said portable units becomes abnormal; means disposed in said base station for transmitting a second asking signal to each of said portable units in response to said response signal and for a predetermined long period; and means disposed in each of said portable units for transmitting a state signal to said base station in response to said second asking signal, said state signal indicating an operation state of each of said portable units. This system is capable of efficiently monitoring portable and relay units with reduced power consumption.

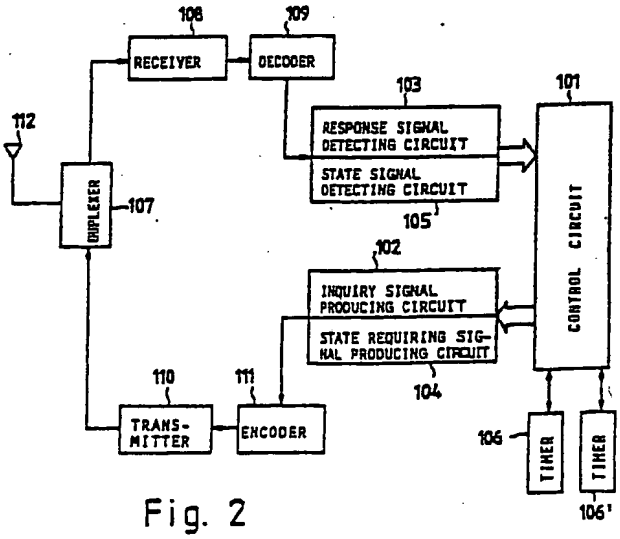


Fig. 2

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# MONITORING SYSTEM FOR RADIO COMMUNICATION APPARATUS

## Background of the Invention

The present invention relates to a radio communication apparatus constructed of a base station, a plurality of portable units disposed around the base station and, in case of need, a relay unit connecting the base station with at least one portable unit, and more particularly, to a monitoring system for a radio communication apparatus for monitoring the operation of the portable unit and relay unit through the base station.

Conventionally, in a radio communication apparatus of this kind, the respective operations of the portable unit and the relay unit are cyclically monitored through the base station for a predetermined period in a polling manner. Namely, the base station transmits an inquiry signal to each of the portable (or relay) units and, then, the portable (or relay) unit which receives the inquiry signal replys an answer signal including information of operation states of the unit, i.e., normal or abnormal states of respective circuitary parts, to the base station. After the reception of the answer signal and a pre-programmed treatment responsive to the answer signal, the base station sequentially transmits the inquiry signal to another unit. If the base station does not receive an answer signal from a unit for a predetermined period (a few seconds, for example) after transmitting the inquiry signal, the base station judges that the unit becomes in a trouble. In this case, the base station transmits the inquiry signal to a next unit after another treatment for the trouble.

In the aforementioned monitoring system of the prior art, however, the base station transmits the inquiry signal to each unit for a relatively short time period and, thus, each unit also transmits the answer signal indicating its state to the base station for such short time period. According to this system, the unit has to respond to the base station even if its operation state is not abnotmal but normal. In this case, each unit is highly frequently accessed and responds for monitoring purpose. Therefore, this monitoring operation causes a wasteful power consumption. This power wastefulness is a serious problem in case the portable (or relay) unit is power-supplied by a battery and is located in remote rural areas.

## Summary of the Invention

It is therefore an object of the present invention to provide a monitoring system for a radio communication apparatus which is capable of efficiently monitoring portable and relay units without inviting wasteful power consumption.

According to the present invention, there is provided a monitoring system for a radio communication apparatus including a base station and a plurality of portable units for monitoring a state of each of said portable units through said base station, comprising: means disposed in said base station for transmitting a first asking signal to each of said portable units for a predetermined short period; means disposed in each of said portable station for replying a response signal in response to said first asking signal only when a state of each of said portable units becomes abnormal; means disposed in said base station for transmitting a second asking signal to each of said portable units in response to said response signal and for a predetermined long period; and means disposed in each of said portable units for transmitting a state signal to said base station in response to said second asking signal, said state signal indicating an operation state of each of said portable units.

## Brief Description of the Drawings

Fig. 1 is a block diagram of a radio communication apparatus to which the present invention can be applied;

Fig. 2 is a block diagram of a base station according to an embodiment of the present invention;

Fig. 3 is a block diagram of a portable unit according to the embodiment of the present invention;

Figs.4(a) and 4(b) are flow charts showing short-period monitoring operations of the base station and the portable unit;

Figs. 5(a) and 5(b) are flow charts showing long-period monitoring operations of the base station and the portable unit;

Figs. 6(a) and 6(b) shows signal-format examples of an inquiry signal and a state requiring signal transmitted from the base station to the portable unit, associated with the short-period monitoring operation and the long-period monitoring operation, respectively;

Figs. 7(a) and 7(b) shows signal-format examples of a response signal and a state signal transmitted from the portable unit to the base station, associated with the short-period monitoring operation and the long-period monitoring operation, respectively; and

Figs.8(a) and 8(b) are flow charts showing monitoring operations which include short-period monitoring and long-period monitoring operations of the base station and the portable unit.

## Description of Preferred Embodiment of the Invention

The present invention will be described in the following in connection with one embodiment thereof with reference to the accompanying drawings.

As shown in Fig. 1, a radio communication apparatus includes a base station 1, a plurality of portable units 2 and, in case of need, at least one relay unit 3 connecting the base station with a portable unit. Further, as shown in Fig. 2, the base station 1 is basically constructed of a control circuit 101, an inquiry signal producing circuit 102, a response signal detecting circuit 103, a state requiring signal producing circuit 104, a state signal detecting circuit 105, timer circuits 106 and 106', a duplexer 107, a receiver 108, a decoder 109, a transmitter 110, an encoder 111 and an antenna 112. As shown in Fig. 3, on the other hand, the portable (or relay) unit is basically constructed of a control circuit 201, an inquiry signal detecting circuit 202, a response signal producing circuit 203, a state requiring signal detecting circuit 204, a state signal producing circuit 205, a state change monitoring circuit 206, a memory circuit 207, a duplexer 208, a receiver 209, a decoder 210, an encoder 211, a transmitter 212 and an antenna 213.

Next, the monitoring system of the present invention will be described with reference to the Drawings.

Under the control circuit 101 (Fig. 2) of the base station, there are provided timers 106 and 106' for short and long time periods, upon which the base station performs monitoring operation for the short period (one second, for example) and the long period (one minute, for example).

In the base station, as shown in Fig. 3(a), the control circuit 101 sets the short-period timer 106 (Step 300) and the inquiry signal producing circuit 102 produces the inquiry signal which is transmitted to one portable (or relay) unit (Step 301). In this case, the inquiry signal contains preamble, a sync code, a code SPM indicating a short-period monitoring operation and an identification (ID) number of the unit to which the base station transmits the inquiry signal, as shown in Fig. 6(a), and is transmitted through the encoder 111,, the transmitter 110 and the duplexer 107.

If the portable (or relay) unit has an operation state change and, thus, sends a response signal within a predetermined period, this signal is detected, through the antenna 112, the duplexer 107, the receiver 108 and the decoder 109, by the response signal detecting circuit 103. Fig. 7(a) shows an example of the response signal containing preamble, a sync code, a response code and the unit ID number. The control circuit 101 determines whether or not the reception is acknowledged within the predetermined period (Step 302). Within the predetermined period, if the response signal is not delivered from the portable (or relay) unit, the determination of the Step 302 is NO, and the routine is returned to the preceding Step 300, so that a next portable (or relay) unit is inquired whether an operation state change is present or not.

If, on the contrary, the reception acknowledgement is present within the predetermined time, the determination of the Step 302 is YES so that the routine is advanced to Step 303. At this Step 303, the control circuit 101 makes the state requiring signal producing circuit 104 transmit a state requiring signal to the unit which has delivered the response signal. As a result, the state requiring signal is transmitted out through the encoder 111, the transmitter 110, the duplexer 107 and the antenna 112. Fig. 6(b) shows an example of the state requiring signal containing preamble, a sync code, a state requiring code and the unit ID number. Thus, a state signal transmitted from the portable (or relay) unit is detected, through the antenna 112, the receiver 108 and the decoder 109, by the state signal detecting circuit 105 (Step 304). Fig. 7(b) shows an example of the state signal containing preamble, a sync code, state indicating codes and the unit ID number. As a result, the control circuit 101 obtains the state signal and accomplish a predetermined treatment. After this, the routine is returned to the preceding Step 300, and a next portable (or relay) unit is inquired whether an operation state change is present, or not.

As shown in Fig. 3, in the portable (or relay) unit, on the other hand, the control circuit 201 controls the state change monitor circuit 206 to monitor the occurrence of an alarm or the like in its operation states so that the monitored result is stored and held into the memory circuit 207 (Step 310). At the same time, the determination of Step 311, i.e., whether the inquiry signal is received or not, is accomplished. Namely, the aforementioned inquiry signal delivered from the base station is received and detected by the inquiry signal detecting circuit 202, through the antenna 213, the duplexer 208, the receiver 209 and the decoder 210. If the inquiry signal is assigned to the unit itself, the reception acknowledgement is outputted to the control circuit 201.

As a result, the determination of the Step 311 is YES, and the control circuit 201 then accesses the memory circuit 207 to read out the stored

content to determine whether or not the state has changed (Step 312). If NO, i.e., if the state is not changed and normal, the routine is returned to the preceding Step 310 so that the control circuit 201 performs the monitoring operation of the Steps 310 and 311. If YES, on the contrary, i.e., if the abnormal change (alarm) has been stored, the control circuit 201 makes the response signal producing circuit 203 produce the response signal so as to reply it to the base station. As a result, the response signal is transmitted out through the encoder 211, the transmitter 212, the duplexer 213 and the antenna 213 (Step 313).

After this, when the base station transmits the state requiring signal, this signal is received and detected by the state require signal detecting circuit 204, through the antenna 213, the duplexer 208, the receiver 209 and the decoder 210. If the state requiring signal is assigned to the unit, the detection result is informed to the control circuit 201. As a result, this control circuit 201 performs a determination of Step 314. With the reception acknowledgement, i.e., YES of the Step 314, the control circuit 201 makes the state signal producing circuit 205 transmit the state signal indicating the operation states of respective circultary parts at present. As a result, the state signal is transmitted out through the encoder 211, the transmitter 212, the duplexer 208 and the antenna 213 (Step 315). After this, the control circuit 201 continues the unit monitoring operation (the Step 310).

By the above-mentioned short-period monitoring operation, the base station can detect the unit, in which the operation state is changed to the alarmed state. However, it is conceivable that a portable (or relay) unit is disabled to return the response because of a malfunction such as troubles in the transmitter, the receiver or the power source. Therefore, the base station have a performance of a long-period monitoring operation, in parallel with the short-period monitoring operation thus far described. Figs. 5(a) and 5(b) are flow charts showing monitoring operations of the base station and the portable (or relay) unit according to the long-period monitoring operation. As shown in Fig. 5(a), the base station sequentially transmits a state requiring signal to each of the portable (or relay) units at a relatively long cycle period (one minute, for example). Thus, each of the portable (or relay) units reply a state signal to the base station as shown in Fig. 5(b).

Fig. 8(a) and 8(b) are flow charts showing combination flows of long-period monitoring operation and short-period monitoring operation of the base station and the portable (or relay) unit according to the present invention.

As described in detail hereinbefore, according to the present invention, each portable or relay unit is asked at a short cycle period whether or not its operation state is changed to raise an alarm and is required to informs the present operation states to the base station at a long cycle period. Each unit can be monitored, and only the unit having an operation state change transmits it to the base station for the short-period inquiry. Thus, there can be attained effects that any useless transmission is eliminated and that the power consumption is reduced.

## Claims

1. A monitoring system for a radio communication apparatus including a base station and a plurality of portable units for monitoring a state of each of said portable units through said base station, comprising:
means disposed in said base station for transmitting a first asking signal to each of said portable units for a predetermined short period;
means disposed in each of said portable station for replying a response signal in response to said first asking signal only when a state of each of said portable units becomes abnormal;
means disposed in said base station for transmitting a second asking signal to each of said portable units in response to said response signal and for a predetermined long period; and
means disposed in each of said portable units for transmitting a state signal to said base station in response to said second asking signal, said state signal indicating an operation state of each of said portable units.

2. A monitoring system for a radio communication apparatus including a base station and a plurality of portable units for monitoring a state of each of said portable units through said base station, comprising:
means disposed in said base station for transmitting a first asking signal to each of said portable units for a first predetermined period;
means disposed in each of said portable station for replying a response signal in response to said first asking signal only when a state of each of said portable units is changed in abnormality;
means disposed in said base station for transmitting a second asking signal to each of said portable units in response to said response signal;
means disposed in said base station for transmitting a third asking signal to each of said portable units for a second predetermined period, said second predetermined period being longer than said first predetermined period; and
means disposed in each of said portable units for transmitting a state signal to said base station in

response to said second or third asking signal, said state signal indicating an operation state of each of said portable units.

3. A monitoring method for a radio communication apparatus including a base station and a plurality of portable units, comprising:
transmitting a first requiring signal from said base station to each of said portable units for a first predetermined cycle period;
replying a first response signal from each of said portable units to said base station only when each of said portable units has a change of an operation state;
transmitting a second requiring signal from said base station to each of said portable units when said base station receives said first response signal from each of said portable units;
transmitting a third requiring signal from said base station to each of said portable units for a second predetermined cycle period, said second predetermined cycle period being longer than said first predetermined cycle period; and
replying a second response signal from each of said portable units to said base station in response to said second or third requiring signal, said second response signal including information of the operation state in each of said portable units.

4. A radio communication system including one base station and portable units existing around said base station, for monitoring a state of each of said portable units by said base station, comprising:
means belonging to said base station for inquiring said units sequentially of presence of a change in their operation states for a short period;
means belonging to each of said portable units for storing presence of the change in the operation state thereof;
means belonging to each of said portable units for informing said base station of the change in the operation state thereof;
means belonging to said base station for acknowledging the presence of the change in the operation state of each of said portable unit;
means belonging to said base station for requiring information of the operation state to each of said portable units in response to the acknowledgement of the operation state change;
means belonging to each of said portable units for transmitting the information of the operation state thereof to said base station upon reception of the requirement;
means belonging to said base station for requiring information of the operation state to each of said portable units thereof sequentially for a long period; and
means belonging to said each of said portable units for transmitting the information of the operation state thereof to said base station upon reception of the long period requirement.

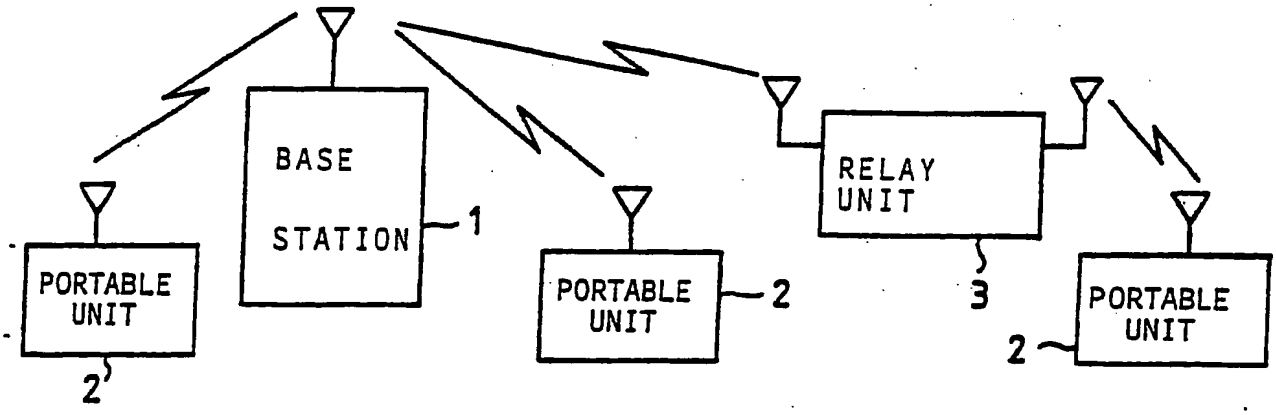

BASE
STATION
1
RELAY
UNIT
3
PORTABLE
UNIT
2'
PORTABLE
UNIT
2
PORTABLE
UNIT
2
PORTABLE
UNIT
2

Fig. 1

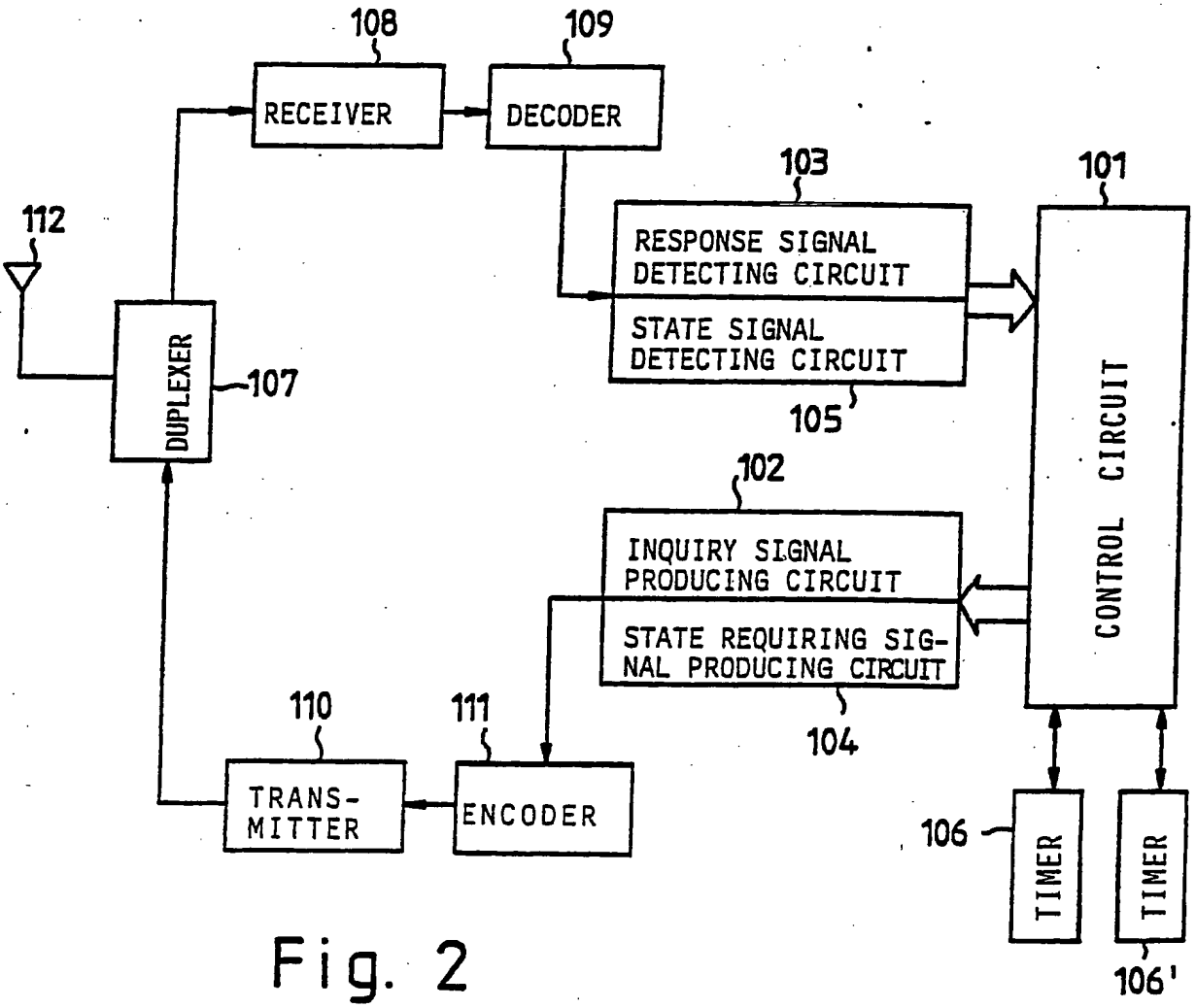

108
RECEIVER
109
DECODER
103
RESPONSE SIGNAL
DETECTING CIRCUIT
STATE SIGNAL
DETECTING CIRCUIT
105
101
CONTROL CIRCUIT
112
DUPLEXER
107
102
INQUIRY SIGNAL
PRODUCING CIRCUIT
STATE REQUIRING SIG-
NAL PRODUCING CIRCUIT
104
110
TRANS-
MITTER
111
ENCODER
106
TIMER
TIMER
106'

Fig. 2

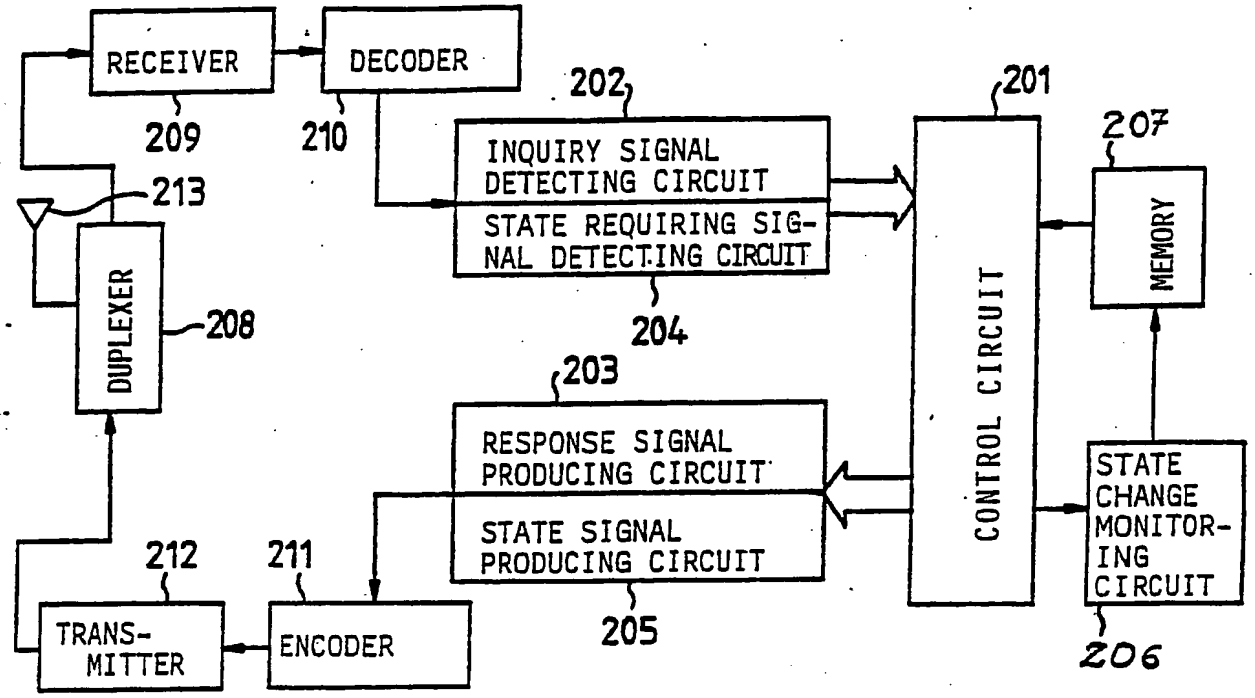



Fig. 3

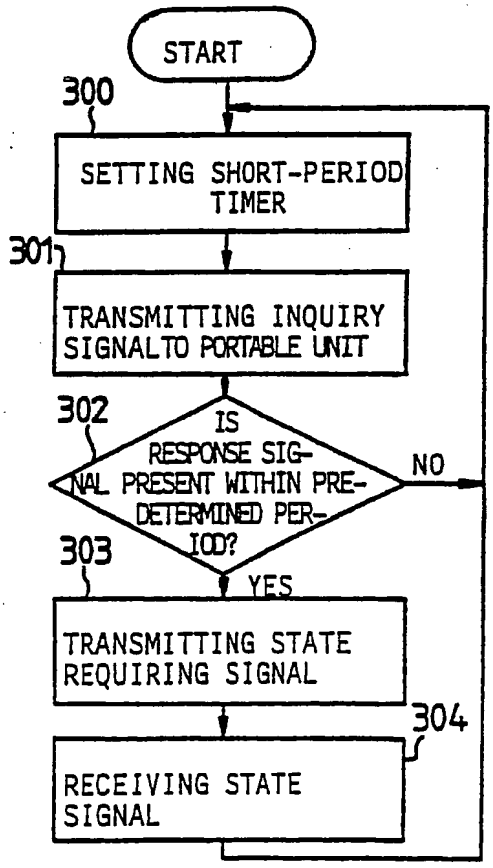
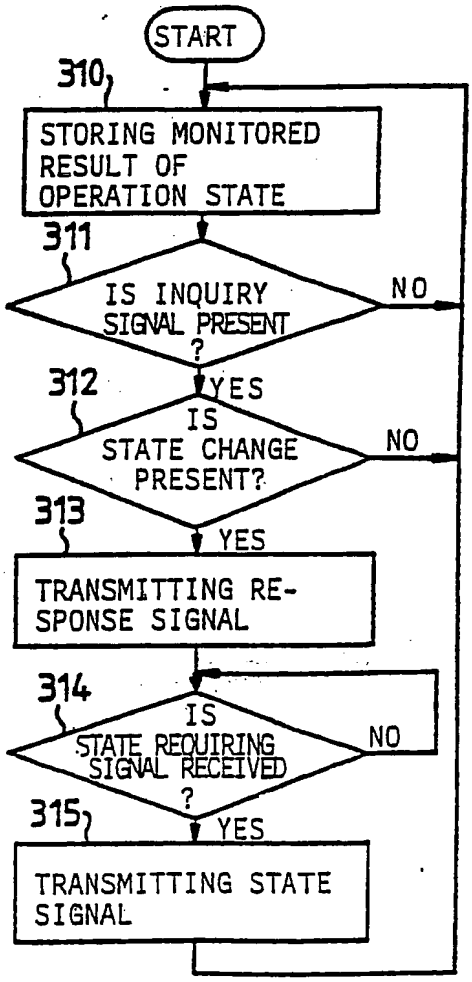



Fig. 4 (a) (BASE STATION)

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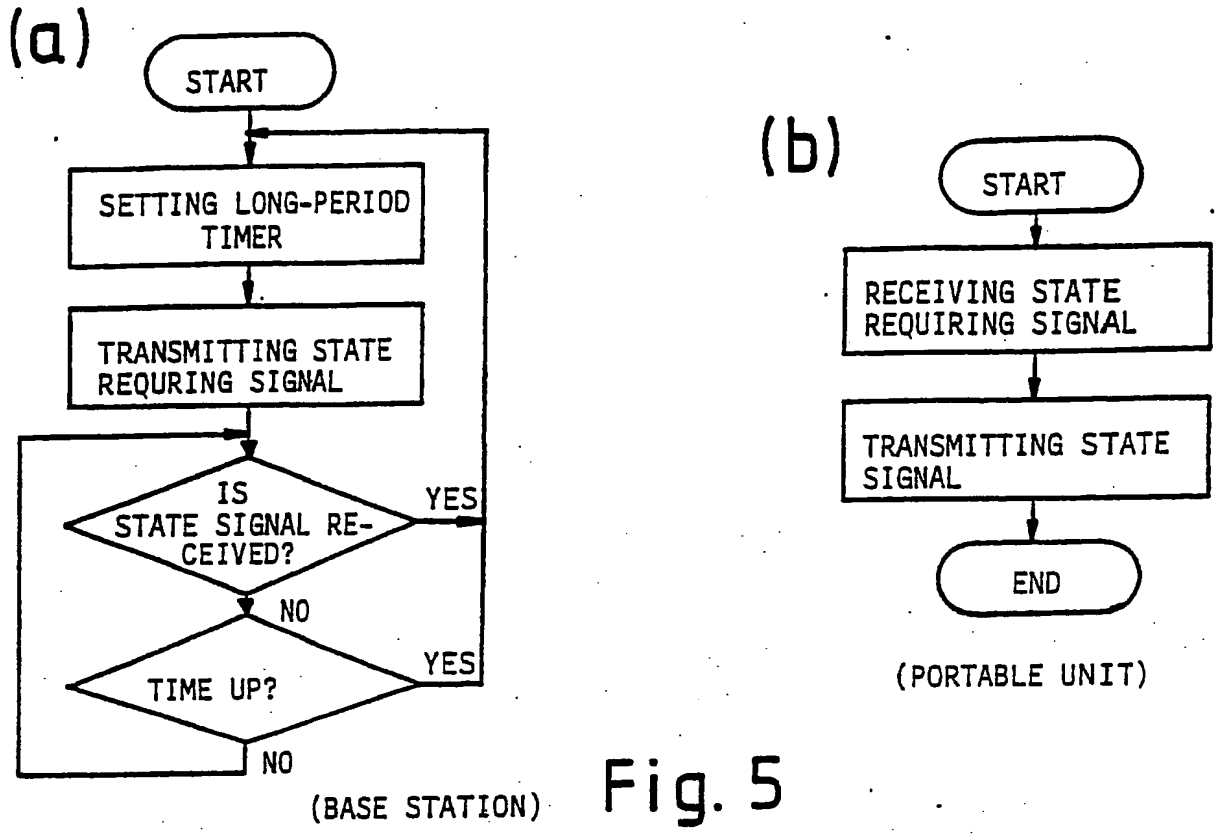



Fig. 5

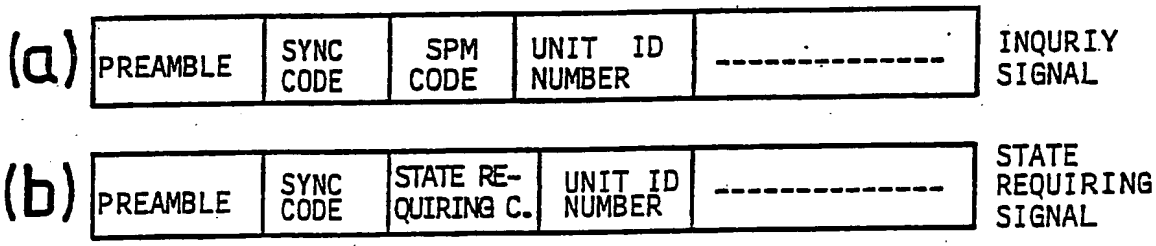



Fig. 6

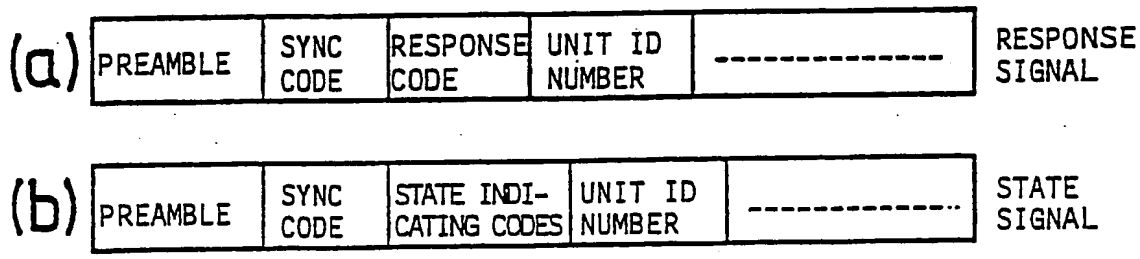



Fig. 7

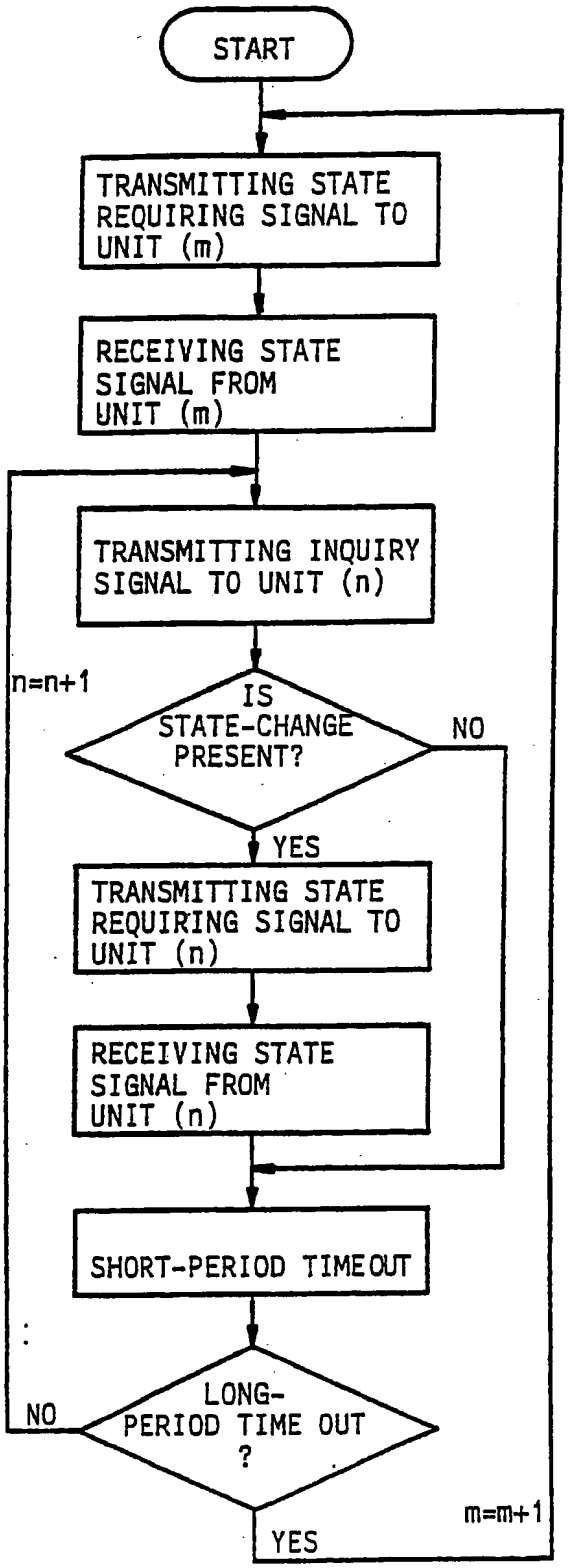
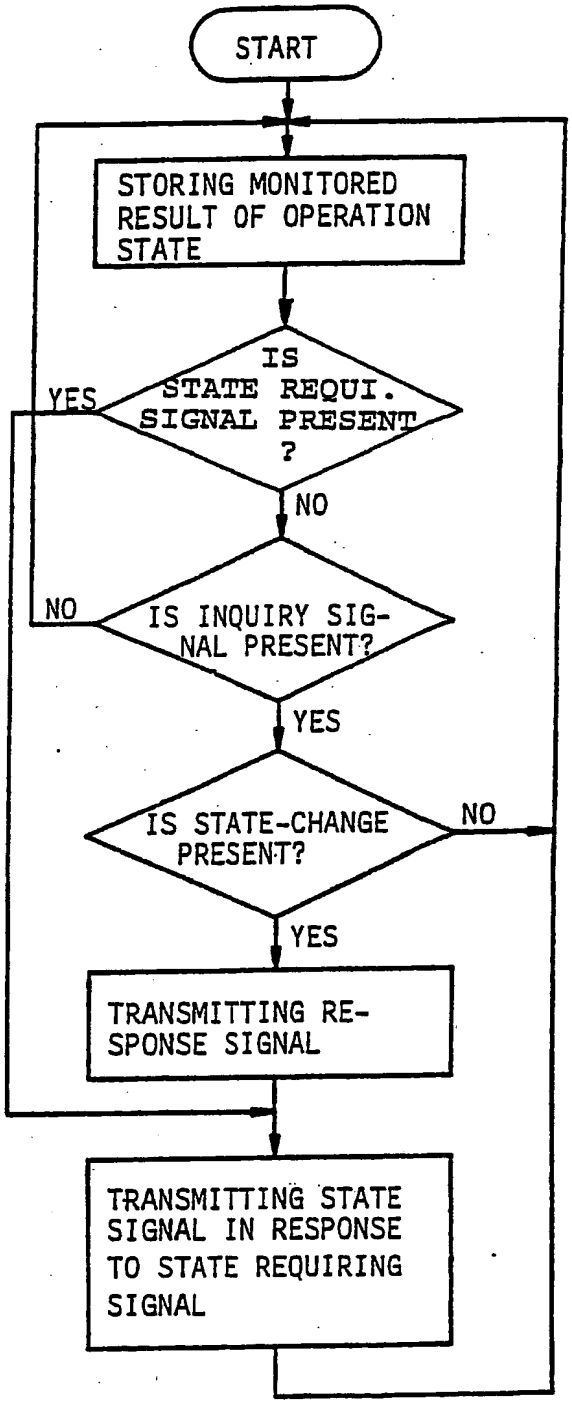



Fig. 8(a) (BASE STATION)

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(b)